GROWTH AND REPRODUCTION OF THE FLANNELMOUTH SUCKER, *CATOSTOMUS LATIPINNIS*, IN THE UPPER COLORADO RIVER BASIN, 1975–76[1]

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ABSTRACT.— Growth rates estimated using the scale annuli of flannelmouth sucker, *Catostomus latipinnis*, did not differ between fish collected from the Gunnison and Colorado rivers, and the Green and Yampa rivers. However, body condition and fecundity were significantly greater in the former population. Age of first maturity for male and female fish from all rivers was IV; and most fish were mature by age VII. The smallest mature female collected was 405 mm, and the smallest mature male was 391 mm total length. Fecundity ranged from 4,000 ova in fish 450 mm long to 40,000 ova in a 500-mm fish: mean ovum diameter was 2.39 mm. Ripe male flannelmouth suckers were collected from early April through June; ripe females were collected from both study areas during May and early June.

The flannelmouth sucker, *Catostomus latipinnis*, is one of the most abundant and widely distributed native fishes in the warm water tributaries and mainstream rivers of the Upper Colorado River Basin (Tyus et al. 1982). However, its distribution in the Lower Colorado River Basin has been substantially reduced by habitat alteration resulting from channelization and water development (Minckley 1973). Despite its importance as a native species endemic to the Colorado River system, little is known of the biology of the flannelmouth sucker (McDonald and Dotson 1960, Wiltzius 1976, Carlson et al. 1979). In this report we describe the growth, maturity, and fecundity of the flannelmouth sucker in the major rivers of the Upper Colorado River Basin.

METHODS

Flannelmouth suckers were collected from the confluence of the Yampa and Green rivers in Dinosaur National Monument and from reaches of the Colorado and Gunnison rivers near their confluence in western Colorado (Fig. 1). Descriptions of sampling sites were provided by McAda and Wydoski (1980), whereas an account of the general physical and ecological features of the large rivers of the Upper Colorado River Basin was provided by Bishop and Porcella (1980).

Fish were sampled between April and November 1975 and 1976 by using trammel nets (26–90 m long, 2.5 cm-mesh inner wall, 25 cm-mesh outerwall) and seines (30 m long, 2.5 cm mesh; and 5 m long, 3 mm mesh) and by electrofishing. Collected fish were weighed (g) and measured in total length (mm). Scales from midway between the lateral line and the anterior insertion of the dorsal fin were used for age determination. An age determination for an individual fish was considered to be accurate when agreement on the number of scale annuli occurred between the first and second examinations. A fish was excluded from analyses that involved fish age when no agreement on the number of scale annuli could be reached after a third examination of the scales.

Total body length (TL, mm) at time of annulus formation was estimated using the equation $TL = b_0 + b_1SR + b_2SR^2 + b_3SR^3$ (Carlander 1956), where SR is the radius to that particular annulus $\times$ 80 and $b_0 - b_3$ are

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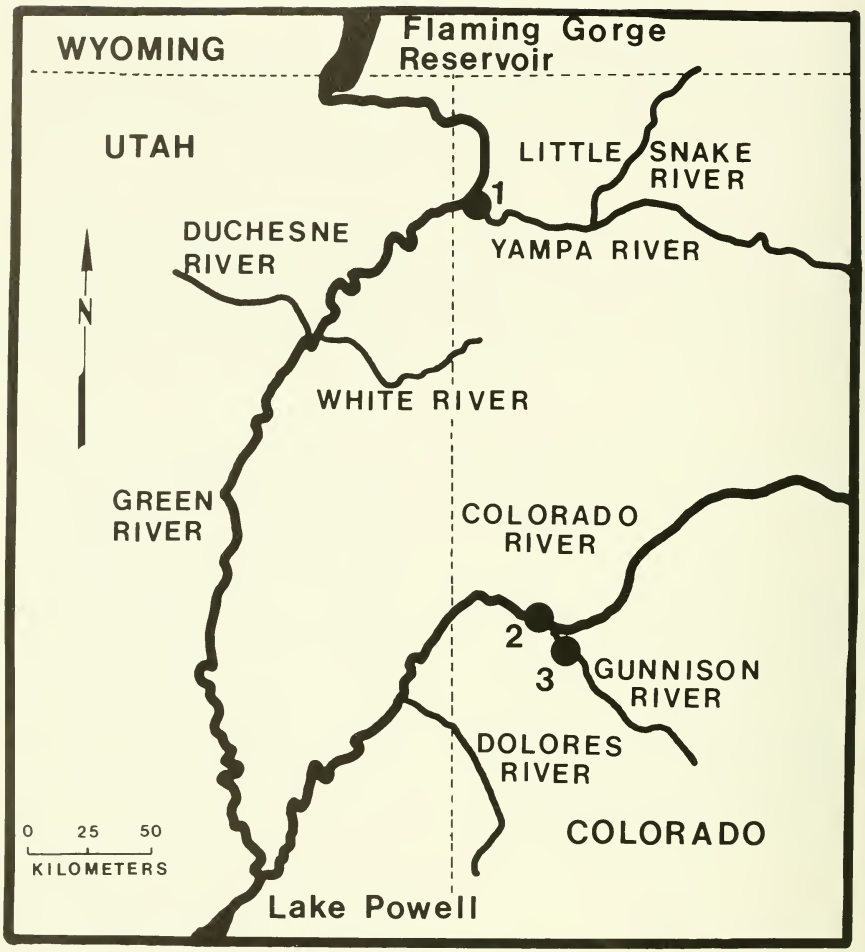

Fig. 1. Locations of sampling points in the Upper Colorado River Basin. (1) Confluence of the Yampa and Green rivers; (2) Colorado River below the mouth of the Gunnison River; and (3) lower Gunnison River.

empirical constants derived using multiple regression analysis. Length-weight relationships were estimated using the equation Log $W = b_1$ Log $TL - b_0$ (Tesch 1971), where W is body weight (g) and b_0 and b_1 are empirical constants derived using least-squares analysis.

Fish were dissected to determine sex and stage of sexual maturity. Females were considered mature when ovaries contained large, opaque, yellow ova; males were considered mature when the testes were enlarged and white. Fish were considered ripe when sex products were expressed with light pressure on the abdomen. Ovaries from mature females collected between April and June 1975 and 1976 were used to estimate fecundity. Fecundity was estimated gravimetrically in the laboratory, where about 10% of each ovary was weighed to the nearest 0.1 g and the individual mature ova from this subsample

Table 1. Length-weight, body-scale and length-fecundity relationships for flannelmouth suckers from the Gunnison, Colorado, Green, and Yampa rivers, 1975–1976.

Length-Weight
Yampa/Green: Log W = 3.13 Log TL – 5.37 (n = 297, R^2 = 0.9)
Colorado/Gunnison: Log W = 3.09 Log TL – 5.21 (n = 292, R^2 = 0.9)
Body-Scale
Yampa/Green Rivers
Male: TL = –18.6342 + 4.8894 SR – 0.0054 SR^2 – 0.0004 SR^3 (n = 139, R^2 = 0.9)
Female: TL = –8.7835 + 3.5187 SR + 0.0131 SR^2 – 0.0001 SR^3 (n = 137, R^2 = 0.8)
Colorado/Gunnison Rivers
Male: TL = –8.7835 + 2.9904 SR + 0.0156 SR^2 – 0.0001 SR^3 (n = 158, R^2 = 0.8)
Female: TL = 46.385 + 0.2820 SR + 0.0443 SR^2 – 0.0002 SR^3 (n = 137, R^2 = 0.8)
Length-Fecundity
Yampa/Green: Log F = 4.03 Log TL – 6.70 (n = 58, R^2 = 0.6)
Colorado: Log F = 3.00 Log TL – 3.76 (n = 45, R^2 = 0.7)
Gunnison: Log F = 3.48 Log TL – 5.14 (n = 15, R^2 = 0.6)

were counted. The fecundity of that fish was then estimated by proportion using total ovary weight. Total counts of ova from two fish demonstrated that estimated fecundity differed from actual fecundity by less than 5%. The mean diameter of mature ova from individual fish was derived from measurements of 30 ova made with an ocular micrometer. The total length-fecundity relationships were determined using the equation Log F = b_1 Log TL – b_0 (Bagenal 1967), where F is fecundity and b_0 and b_1 are empirical constants derived using least-squares analysis.

Statistical comparisons between length-weight, body-scale, and length-fecundity regression equations were made using analysis of covariance (Snedecor and Cochran 1967).

Results

Age and Growth

About 80% of the flannelmouth suckers used in our analyses were collected between April and July. The collection from the Gunnison River was made in April 1976. Body-scale relationships differed significantly between male and female fish among the study areas ($P<0.05$: Table 1). However, mean length at annulus formation was similar for the study groups and they were averaged for this report (Fig. 2). Average growth increments of all fish were greatest at the formation of the third annulus and declined steadily thereafter.

Data for the two sexes were combined because there was no significant difference between the length-weight relationships for male and female flannelmouth suckers ($P>0.05$). No statistical difference was detected between length-weight regressions from data on fish from the Gunnison and Colorado rivers ($P>0.05$). Flannelmouth suckers from the Colorado and Gunnison rivers were significantly heavier than fish of equal length from the Yampa and Green rivers ($P<0.001$: Table 1).

Reproduction

In the Colorado and Gunnison River collections, the smallest mature female was 421 mm long, and all females longer than 490 mm were mature. The smallest mature male was 391 mm long, and all males 470 mm or longer from the Colorado and Gunnison rivers were mature. In the Yampa and Green River collections, the smallest mature male was 393 mm long, and all males were mature at 460 mm: the smallest mature female was 405 mm long and all females were mature at 470 mm (Table 2). Thus, fish began to mature at age IV and most were mature by age VI.

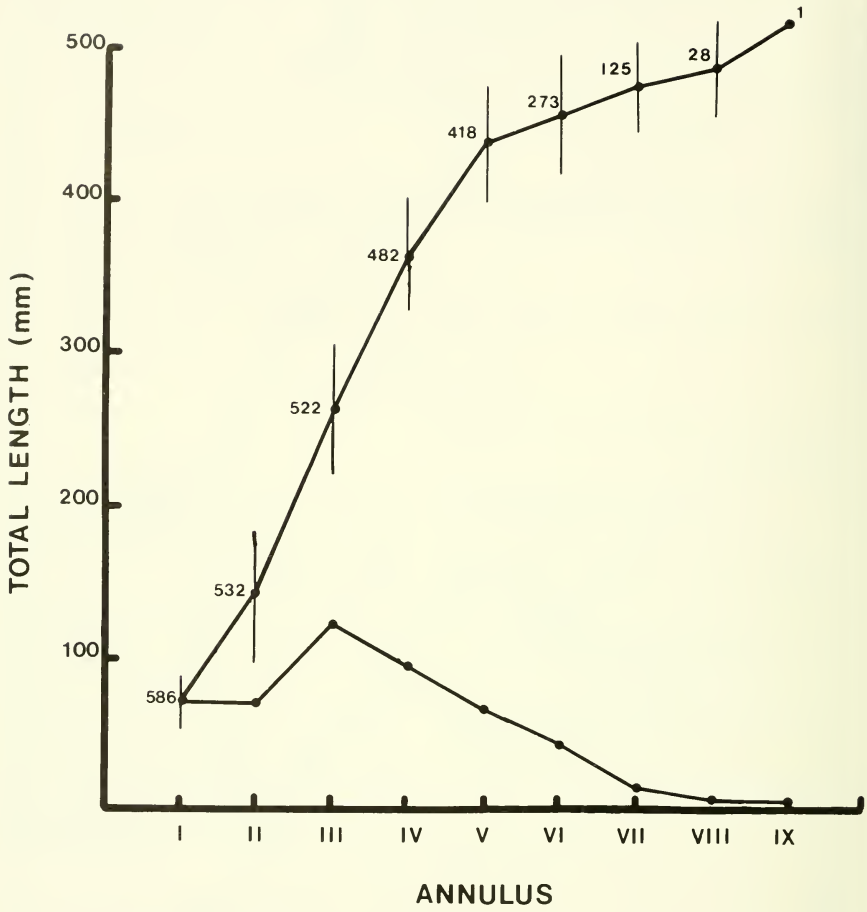

Fig. 2. Mean total length and growth increments at annulus formation for male and female flannelmouth suckers from the Gunnison, Colorado, Green, and Yampa rivers, 1975–1976. Numbers indicate sample size. Bars indicate one standard deviation.

The diameters of preserved, mature ova ranged from 1.99 to 3.15 mm (mean = 2.39 mm; n = 49). The relationship between ova diameter and fish length was not significant ($P > 0.05$).

Fish from the Yampa and Green rivers produced significantly fewer mature ova than did fish from the Gunnison or Colorado rivers ($P < 0.001$: Table 1). Flannelmouth suckers from the Gunnison River also produced significantly fewer ova than did those from the Colorado River. Based upon the regression equations, a fish 450 mm long from the Yampa River produced about 9,800 ova, whereas fish of this length from the Gunnison and Colorado rivers produced about 12,700 and 15,900 ova, respectively.

Ripe male flannelmouth suckers were collected from both study areas when sampling began in early April and on through June.

Table 2. Relation of total length to sexual maturity in flannelmouth suckers from the Yampa, Green, Colorado, and Gunnison rivers, 1975–1976.

Total length (mm)	Colorado and Gunnison Rivers				Yampa and Green Rivers			
	Female		Male		Female		Male	
	Number of fish	Percent mature	Number of fish	Percent mature	Number of fish	Percent mature	Number of fish	Percent mature
381–390	3	0	4	0	1	0	3	0
391–400	3	0	6	17	1	0	1	100
401–410	1	0	6	33	5	20	3	100
411–420	2	60	7	71	2	0	5	80
421–430	5	0	6	67	7	43	7	100
431–440	2	60	6	100	3	67	19	100
441–450	9	75	11	91	5	40	18	94
451–460	4	80	14	93	6	67	12	92
461–470	5	100	16	100	14	93	11	100
471–480	7	92	14	100	9	100	11	100
481–490	14	100	12	100	5	100	9	100
491–500	15	100	6	100	9	100	1	100
501–510	8	100	5	100	13	100	4	100
511–520	9	100	2	100	10	100		
521–530	13	100	1	100	3	100		
531–540	7	100			5	100		
541–550	5	100			3	100		
551–560	7	100			–	–		
561–570	1	100			2	100		
571–580	–	–			1	100		

Ripe females were collected in May and early June, but none were collected after this period.

In the Yampa and Colorado rivers, ripe male and female flannelmouth suckers were collected at the upstream points of cobble bars in water about 1 m deep, with a water velocity of about 1 m/sec. Although spawning activity was not observed, the presence of ripe females (collected only over the cobble bars) suggested that spawning probably occurred nearby. Flannelmouth suckers reproduced successfully in both 1975 and 1976 as evidenced by the abundant young of the year (30–40 mm TL), which we readily captured at all study areas by midsummer.

Discussion

The back-calculated length of flannelmouth suckers at the time of annulus formation for annuli I and II were similar to those estimated by McDonald and Dotson (1960) for flannelmouth suckers from the upper Green River and by Carlson et al. (1979) for fish from the upper Yampa River; however, our estimates of total body length at the formation of annuli III and greater were longer than their estimates. They also observed a decline in annual growth increments at age IV, similar to this study, which probably reflects the diversion of energy from growth to reproduction at the onset of reproductive maturity.

Although annual growth increments did not differ significantly between rivers, the significant difference in the length-weight relationships reflects heavier body weight for a given length of fish from the Colorado and Gunnison rivers. This observation probably reflects a difference in the nutritional status of the fish examined in this study. However, the similarity between back-calculated length at annulus formation during previous years suggests that these differences may not always occur. Similar differences in weight of razorback sucker, *Xyrauchen texanus*, and fecundity of bluehead sucker, *C. discobolus*, from these study sites were observed by McAda and Wydoski (1980, 1983 [respectively]) during the same period. Although this observation probably reflects a difference in the nutritional status of the fish examined in this study, we cannot speculate whether this phenomenon represents consistent differences between the two study areas or merely reflects differences that occurred during the study period. However, the similarity be-

tween back-calculated lengths at annulus formation during previous years suggests that these differences may not always exist.

Vanicek and Kramer (1969) documented a decline in the growth rate of Colorado squawfish, *Ptychocheilus lucius*, and roundtail chub, *Gila robusta*, in the Green River after the closure of Flaming Gorge Dam, which they attributed to the resultant decrease in water temperature. Although probably a contributing factor, the lower water temperature in the Green River cannot be completely responsible for the observed differences in fecundity and body weight because flannelmouth suckers in this study were primarily collected in the mixing zone of the Green River with the Yampa River, which maintains its historic temperature regime.

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